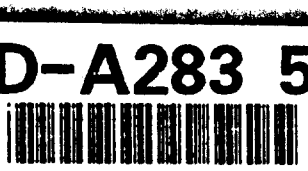

Naval Command,
Control and Ocean
Surveillance Center

RDT&E Division

San Diego, CA
92152-5001

**Technical Document 2626**
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# Data Processing Routines for the Sippican MK-12 XBT System

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## ADMINISTRATIVE INFORMATION

This unfunded work was performed during FY 93 by the Advanced Systems Operations Branch (Code 742) of the Advanced Surveillance Concepts and System Engineering Division (Code 74) at the Naval Command, Control and Ocean Surveillance Center Research, Development, Test and Evaluation Division (NRaD) in San Diego, California. The work addresses the need for improved quality in data entry into tactical decision aids.

Released by
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Advanced Systems
Operations Branch

Under authority of
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Advanced Surveillance
Concepts and Systems
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BV

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# INTRODUCTION

## BACKGROUND

Expendable BathyThermograph (XBT) messages are the prime source data available to the U.S. Navy for entry into acoustic performance prediction models and environmental studies; therefore, suitably equipped naval aircraft and vessels are required to submit XBT reports in a message format (officially called BATHY messages, but unofficially called JJXX messages after the first message group) in accordance with instructions promulgated by the Chief of Naval Operations (references 1 and 2). Unfortunately, error rates greater than 63 percent have been observed during the process of manually encoding the data for message transmission (references 3 and 4). Although the Fleet Numerical Oceanography Center filters the BATHY message traffic for gross errors, the process cannot detect subtle errors, such as failure to properly delineate a secondary sound channel or minor positional errors. These errors result in (1) selection of less than desirable tactical procedures based on faulty acoustic performance predictions, and (2) erroneous representation of ocean features (fronts, eddies, or sound channels) by circulation models.

## OBJECTIVES

The Sippican MK-12 Oceanographic Data Acquisition System, referred to as the MK-12 XBT system, has the capacity to overcome the aforementioned problems and can be used aboard surface vessels, submarines, and aircraft. Unfortunately, the Sippican MK-12 XBT system does not include the capability to smooth, edit, or output XBT data in BATHY message format. The experimental software program developed by NRaD, and described herein, is designed to assist the user in performing these missing functions in addition to computing other parameters, such as cut-off frequency, that are unavailable elsewhere. It is believed that these MS-DOS routines will be compatible with most IBM-compatible personal computers.

# SIPPICAN MK-12 OCEANOGRAPHIC DATA ACQUISITION SYSTEM

## GENERAL DESCRIPTION

The MK-12 XBT system consists of a multifunction interface card for an IBM-compatible personal computer, a Sippican XBT launcher, and Sippican expendable probes. The interface card requires an 8-bit expansion slot capable of supporting MS-DOS version 3.0 (or higher), and an onboard RAM with 640 Mb, or more, of mass storage. The XBT probe is deployed from either a fixed or hand-held launcher with a 10-Hz signal passing through a connector box to the interface card. The conductivity XCTD probe uses a 4-Hz sampling rate. Probe depth is assumed from the known fall rate of the probe. The recorder (MK-12 or AN/BQH-7) is bypassed by the MK-12 XBT system; thus, the program described is the only way to obtain a graphic of the temperature profile.

Although the MK-12 XBT system can support temperature, sound speed (XSV), and conductivity (XCTD) probes, the software described herein is designed to be used with XBT data only. This is reasonable because XSV and XCTD data account for only a small fraction of

all probes expended. Although not tested, it is expected that the routine would work with XBT probes manufactured by Sparton of Canada.

## SOFTWARE PROGRAM MK12 OVERVIEW

### Major Functions

The Software Program MK12, referred to as Program MK12, has six major functions:

1. Read the raw depth and temperature data.
2. Provide a temperature profile plot.
3. Smooth the data to a user-designated number of points based on an algorithm developed by the National Oceanic and Atmospheric Administration (reference 5).
4. Edit the smoothed profile through both addition or subtraction of points to the profile, or by truncation.
5. Write the BATHY message in either classified or unclassified message format.
6. Print the smoothed trace and the significant acoustically related information.

### Data Storage

In-situ XBT data are normally downloaded by the MK12 XBT software to the hard disk (usually drive C:). If Program MK12 is installed, the routine may be directed to read that drive automatically. If Program MK12 is not installed, the stored data must be downloaded to a diskette for later processing. The Program MK12 has the flexibility to operate from various drives by using variable file names, and by storing these file names and other pertinent information in an integral file (MK12.IDX) for later use.

### Temperature Profile Display

An XBT profile, plotted by Program MK12, is shown in figure 1. The raw trace is shown as a continuous line, the smoothed trace by open dots. Profile identification, printed in the upper right-hand corner of the plot, was decoded from the stored profile header information. Temperature and depth limits were selected automatically; however, the user can modify these values to make them agree with previous plots. Note that the user has the options of (1) ACCEPT TRACE for accepting the trace as shown, (2) ADJUST TRACE for modifying the trace as discussed later, or (3) IGNORE TRACE for ignoring the trace altogether.

The latter option, (3) IGNORE TRACE, would be exercised when it is obvious that the profile is erroneous. Probe failure may cause profiled data errors, resulting from a number of factors including (1) incomplete system maintenance, (2) probe storage inconsistent with recommended procedures, and (3) adverse environmental conditions. Since the graphics package required to capture and print the CRT graphic is not included as part of Program MK12, the display shown was downloaded using Deluxe Print II Enhanced, a product of Electronic Arts, Inc.

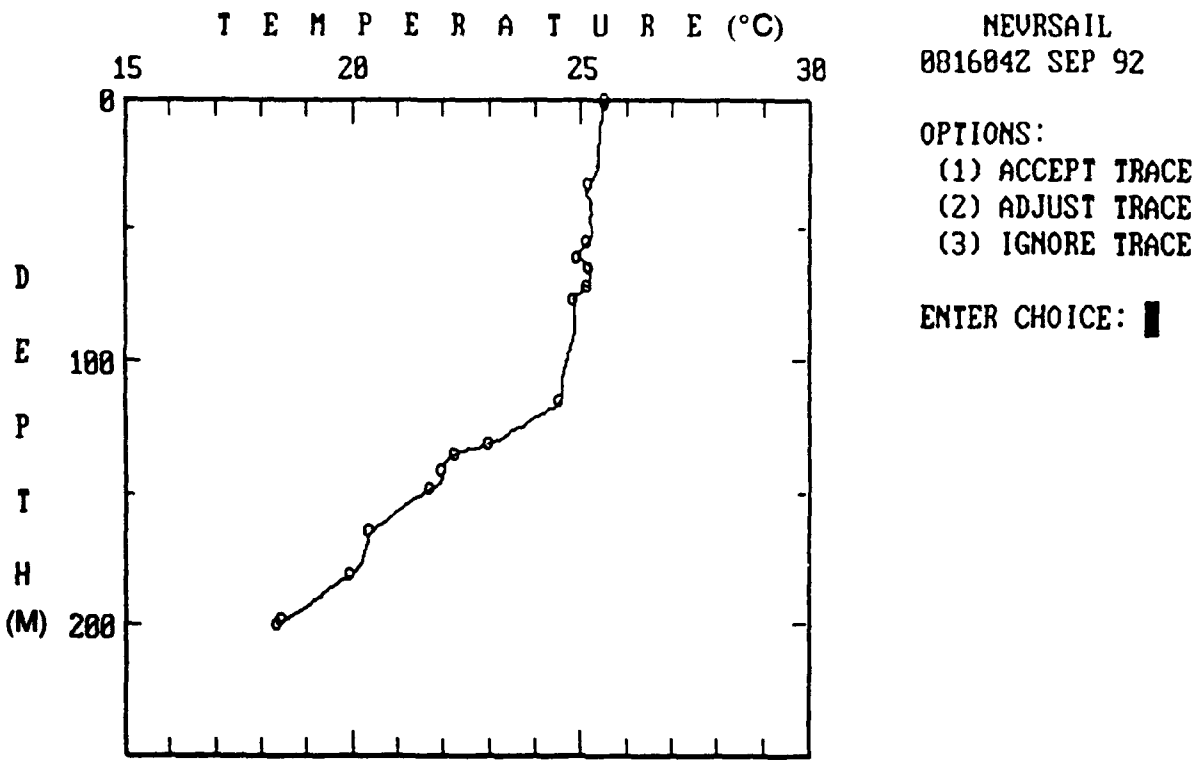



Figure 1. XBT profile generated by Program MK12.

**Smoothing Routines**

The smoothing routine reduces the profile to a number of depth-temperature pairs (a maximum of 60) as designated by the user. A default value of 30 is used (1) to agree with typical size limitations of acoustic models, and (2) to keep BATHY messages at a reasonable size. The temperature filter is originally set to 0.10°C, but increases by 10% on each pass until the desired number of points is achieved. Should this not be possible, the user will be given the option to double the filter size. Profile reduction is on the order of 15- to 20-fold with a filter size set to 0.10°C.

**Editing Process**

The editing process permits (1) addition or subtraction of smoothed points, or (2) plot truncation below a specified depth. Addition of points is desirable when it appears that the smoothing process missed acoustically important points, such as (1) sound channel axial depth or limits, or (2) sonic layer depth. Point deletion is helpful in eliminating spurious features, such as temperature spikes caused by pinhole leaks in the probe wire or electronic interference. Profile truncation is required due to (1) probe failure, as indicated by a rapid traverse of the profile toward high temperature, or (2) continuation of the profile below maximum bottom depth. Bottom strike is indicated frequently, but not always, by a slight increase or decrease of temperature at constant depth, followed by an isothermal or slightly increasing temperature profile.

**Expanded Profiles**

An expanded profile (figure 2), covering ±25 meters from a user-selected depth, provides better profile definition during the editing process. Raw points on the profile are indicated with

an arrow that is moved downward by pressing the RETURN key until the desired depth is reached, whereupon "Y" is entered by the user.

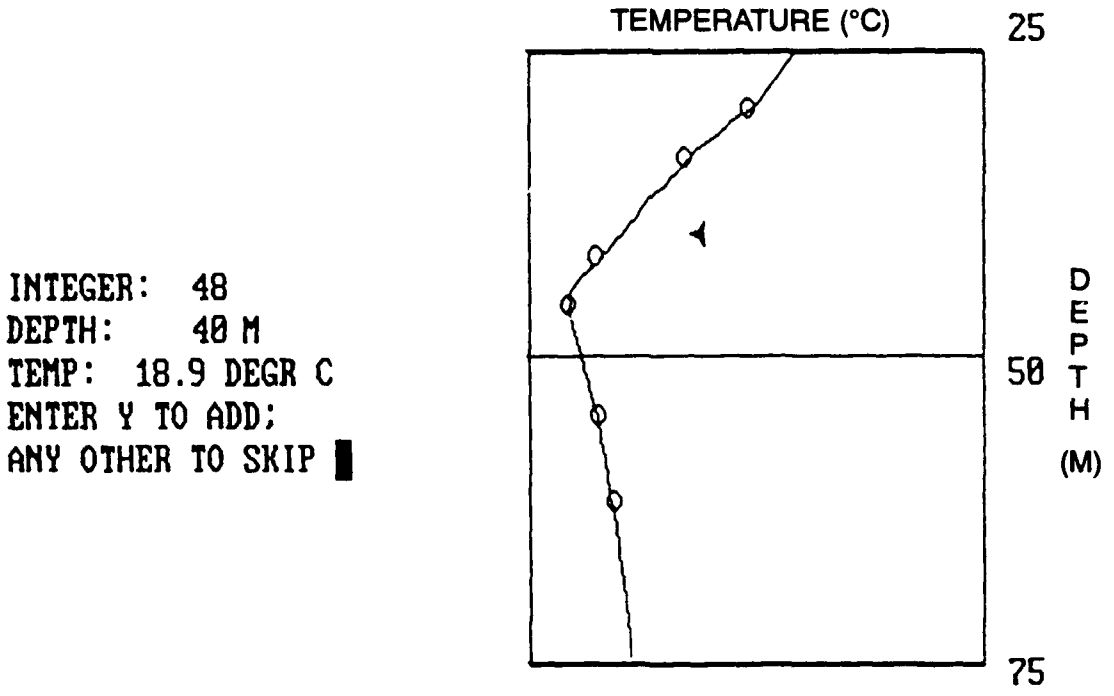



Figure 2. Expanded plot used for XBT editing.

**BATHY Message Reports**

The BATHY message (figure 3) is generated from the smoothed profile. Message administration information (originator, addressee, up to five addees, unit call sign) selected by the user is stored in file MK12.IDX and added to the message automatically. The user has the ability to select message classification and precedence. Downgrading information will be added automatically at the end of classified messages.

**Trace Printout**

If desired, a listing of the smoothed trace and acoustically important points can be printed as shown in figure 4. Note that the latter were computed using constant salinity or 35 parts per thousand (o/oo); thus, the acoustic feature described may differ from actual conditions in the presence of strong haloclines in the near-surface area. Although often associated with coastal or polar areas where fresh water is abundant, haloclines, sufficiently strong so as to affect the sound speed profile, occur in the Northern Pacific Ocean, the Sargasso Sea, the North Arabian Sea, and the Persian Gulf.

```
                    ****************
                    * UNCLASSIFIED *
                    ****************

ROUTINE

R 161223Z SEP 92

FM USNS NEVRSAIL

TO OCEANO EAST

INFO NAVLANTMETOCFAC ROTA SP
     NCCOSC RTDE DIV SAN DIEGO //742//
     NAVOCEANO STENNIS SPACE CENTER //OSP//

UNCLAS          //N03160//

SUBJ: BATHY MESSAGE REPORT

 JJXX 09162 1223/ 13608 12930 88888 00252 02251 04246 15241

 17237 18224 20208 22197 24190 30179 34164 42145 46139 62149

 93156 99901 51161 99902 00161 NHDK

BT
                    ****************
                    * UNCLASSIFIED *
                    ****************
```

Figure 3. A BATHY message generated by Program MK12.

```
UNIT: NEVRSAIL   DTG: 161223Z SEP 92   POSIT: 36-08N 129-30E

SMOOTHED POINTS:  17     RAW POINTS:  321

   DEPTH     TEMP     DEPTH     TEMP     DEPTH     TEMP     DEPTH     TEMP

       0     25.2         2     25.1         4     24.6        15     24.1
      17     23.7        18     22.4        20     20.8        22     19.7
      24     19.0        30     17.9        34     16.4        42     14.5
      46     13.9        62     14.9        93     15.6       151     16.1
     200     16.1

TOLERANCE FACTOR: 0.10

SONIC LAYER DEPTH IS AT 2 M WITH A SFC LAYER CUT-OFF FREQ GRTR THAN 5000 HZ.

SECONDARY SOUND CHANNEL ANALYSIS:

             CUT-OFF      AXIAL      UPPER      LOWER
               FREQ       DEPTH      LIMIT      LIMIT    THICKNESS
     N        (HZ)         (M)        (M)        (M)        (M)

     1          29          46         32        200        168

NOTE: ABOVE PARAMETERS COMPUTED USING CONSTANT SALINITY.
```

Figure 4. Printout of the XBT profile and acoustic information.

# CONCLUSION

The effectiveness of the smoothing and editing routines is evident from figures 1 and 2. The ability to automatically encode the BATHY message should reduce the high error rate by a significant amount. Cutoff frequencies given in the printout (figure 4) are unavailable in standard Navy acoustic performance prediction model; therefore, it is believed that Program MK12 offers a significant improvement in the ability to process and report both in-situ data during at-sea experiments and later reconstruction of the environment during the laboratory simulations. Appendix A describes the operation of Program MK12.

# REFERENCES


1. Chief of Naval Operations. "Collection and Reporting of Bathythermograph Observations," OPNAVINST 3151.1. 1990.

2. *Bathythermograph Log*, OCEAN 3167/1.

3. Fisher, A., Jr., and L. Riley. "An Investigation of XBT Encoding Errors and Their Effect on Sonar Range Prediction," Naval Oceanographic Office, TR 234, 12 p. 1977.

4. Fisher, A., Jr. *How Important is XBT Coding?*, Tactical Alert. 1991.

5. NOAA. *SEAS III SOFTWARE; Version 2.1*, National Ocean Services, Ocean Observation Div.; unnumbered. 1988.

# APPENDIX A—PROGRAM MK12 OPERATION

The most likely means of operating Program MK12 is with the main routine (MK12.EXE), set up files (MK12.IDX) on the hard drive, and the raw and smoothed data (user-assigned file names) on either a diskette or in separate directories on the hard drive. Subdirectories for the raw and smoothed data can be created with the MS-DOS command Make Directory (MD) using the names XBT_DATA and SMUTH, respectively.

1. The program is started by typing <MK12> then pressing <ENTER>. The program immediately activates the uppercase mode and turns off the number lock.

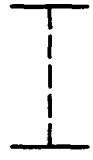
   NOTE

   Henceforth, computer commands and responses in the text will be enclosed in the "<" and ">" symbols; for example, <N> denotes a negative response.

2. The user will be asked to verify that file MK12.IDX is stored in drive A:. If not, the appropriate drive designator (for example, C:) should be entered. Be sure to add the colon (:) after the letter designator.

3. MAIN MENU. The user must then indicate the operation mode desired from the following Main Menu.

   (1) PROCESS XBT DATA
   (2) UPDATE SET UP FILE
   (3) PRINT XBT DIRECTORY
   (4) END PROGRAM

   Main Menu

4. Option mode (2) UPDATE SET UP FILE will be examined first as it prepares the set up file MK12.IDX for later use. The user will be asked to either verify or change the items in this file. Affirmative and negative responses should be answered by <Y> or <N>. The program requests that all changes be verified. Information requested and typical responses are as follows:

   RAW XBT DATA IS IN DRIVE A: <Y>

   ENTER FILE EXTENSION FOR RAW XBT DATA (OMIT '.') <EXP>

   SUBDIRECTORY 'SMUTH' IS IN DRIVE A: <Y>

   FILE EXTENSION FOR SMOOTHED DATA IS '.XBT' <Y>

   ENTER NAME OF OWN UNIT: <NEVERSAIL>

   ENTER OWN UNIT'S RADIO CALL SIGN: <NHDK>

ENTER BATHY MESSAGE ORIGINATOR: <USNS NEVERSAIL>

ENTER BATHY MESSAGE ADDRESSEE: <OCEANO EAST>

ARE THERE INFO ADDEES ON THE BATHY MESSAGE? <Y>

ENTER INFO ADDEE #1: <NCCOSC RDT&E DIV SAN DIEGO //742//>
DO YOU WANT TO ENTER ANOTHER INFO ADDEE? <N>

INFO ADDEES ARE:
NAVLANTMETOCFAC ROTA SP
NCCOSC RDT&E DIV SAN DIEGO //742//
NAVOCEANO STENNIS SPACE CENTER //N3211//
. . .

ARE INFO ADDEES CORRECT? <Y>

ENTER UNIT NAME FOR GRAPHICS (10-LTR MAX): <NEVERSAIL>

SET UP FILE C:\SMUTH\MK12.IDX COMPLETED

5. Option mode (3) PRINT XBT DIRECTORY provides a printer dump of subdirectory XBT_DATA. Because the program accesses data by file name, it is recommended that this option be exercised whenever new data become available.

6. Option mode (1) PROCESS XBT DATA allows the user to operate on individual XBT traces. The name of the XBT trace to be processed is entered by the user when requested. The program will then extract the data from file XBT_DATA and will examine it for inconsistencies. If geographic position or hemisphere cannot be determined, the user will be asked to supply the missing information.

7. SMOOTHING PROCESS. The smoothing process will begin upon satisfactory processing of the raw data. The program will inquire if the maximum number of smoothed points should be set at 30. Any number greater than 3 (and less than or equal to 60) is acceptable. It should be kept in mind that a small number of points results in more smoothing time and possible overloading of the smoothing factor, while a larger number creates a long BATHY message. Experience has shown that 30 points offers a reasonable compromise. Should the smoothing be excessive or complex, the user will be asked if (1) the size of the filter should be doubled, or (2) the process should be terminated and another observation be selected.

8. The raw and smoothed profiles will be plotted upon completion of the smoothing process. Scaling is performed automatically by the program, but the operator has the opportunity to modify the plot limits by entering new limits to maintain consistency with previous plots.

9. TRACE EDIT DATA MENU. When the plot has been completed, the Edit Data Menu will appear on the right-hand side of the plot as shown in figure 1 of the main text and as follows:

(1) ACCEPT TRACE
(2) ADJUST TRACE
(3) IGNORE TRACE

— Edit Data Menu

Normally, a trace requires little adjustment and option (1) ACCEPT TRACE will be used; however, if it appears that a significant inflection point or an acoustically relevant feature (for example, sonic layer depth, sound channel axis, or limit) was omitted, the user may adjust the profile by using option (2) ADJUST TRACE. It should be noted that one or more points may have to be eliminated, if the addition of points causes the total number to exceed the maximum allowable number. Option (2) also should be used to eliminate one or more points if it appears that (1) spurious temperature spikes occurred, or (2) the trace extended beyond bottom depth. If the profile is to be truncated, first add a point immediately above the depth of truncation. Option (3) IGNORE TRACE should be used if the trace appears to have malfunctioned and useful data cannot be salvaged.

10. If option (2) ADJUST TRACE is selected, the user will be asked the approximate depth, in meters, of the change. The program will round off this depth, to the nearest 25 meters, and will create an expanded profile around this depth (figure 4 of the main text).

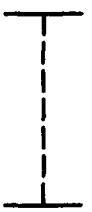
    a. If a point is to be added, the user moves the arrow downward by repeatedly pressing the <ENTER> key until the desired depth is reached, when <Y> is entered. If the arrow moves beyond that depth, it will recycle to the top of the trace upon reaching maximum depth of the expanded plot. Note that integer number, depth, and temperature of each point on the raw trace appears to the left of the graphic as the arrow moves downward.

    b. If the delete option is selected, the integer number will appear adjacent to each smoothed point. Enter the respective integer number to remove the desired point from the profile.

    c. If the trace is to be truncated, the user should ensure the smoothed profile includes a point immediately above the depth of truncation. If not, add one point using option (2).

11. PRODUCT MENU. When the smoothed trace has been accepted, the Product Menu will appear:

(1) PRINT SMOOTHED PROFILE
(2) SAVE SMOOTHED TRACE
(3) PREPARE BATHY (JJXX) MESSAGE
(4) GET ANOTHER OB
(5) END PROGRAM



— Product Menu

Option (1) PRINT SMOOTHED PROFILE will cause the program to compute sound speed as a function of depth, temperature, and constant salinity of 35 parts per thousand and to examine the profile for acoustically relevant inflection points. If option (2) SAVE SMOOTHED TRACE is selected, the smoothed trace will be saved in subdirectory SMUTH.

Selection of option (3) PREPARE BATHY (JJXX) MESSAGE will cause the program to query the user as to the correctness of message originator, addressee, and the information addresses. If correct, the routine will continue; if incorrect, the user will be asked to update file MK12.IDX. The user will be asked then to indicate message classification (UNCLASSIFIED, CONFIDENTIAL, SECRET) and precedence (PRIORITY, ROUTINE). The message will then be encoded and proper downgrading information will be added, if classified.

The program will ask the user if another XBT profile should be extracted by using option (4) GET ANOTHER OB. When finished, the user will select option (4) END PROGRAM to exit the software program.

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**12a. DISTRIBUTION/AVAILABILITY STATEMENT**

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**12b. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)*

This experimental software program is designed to assist the user to smooth, edit, and output expendable bathythermograph (XBT) data in BATHY message format. The MS-DOS routines described in this document should be compatible with most IBM-compatible personal computers.

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